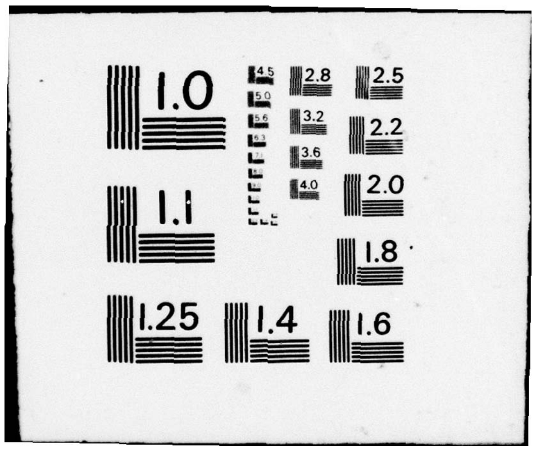
AD-A033 379 ARMY ENVIRONMENTAL HYGIENE AGENCY ABERDEEN PROVING GR--ETC F/G 6/18
EVALUATION OF THE LASER INSTRUMENTATION BEACON DEVELOPED FOR OP--ETC(U)
DEC 76 T L LYON

UNCLASSIFIED USAEHA-42-0306-77 NL

1 OF 1
ADA033379

END
DATE
FILMED
2 - 77


1.0
4.5
5.0
5.6
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

NONIONIZING RADIATION PROTECTION SPECIAL STUDY NO. 42-0306-77
EVALUATION OF THE LASER INSTRUMENTATION BEACON
DEVELOPED FOR OPERATIONAL TEST AND EVALUATION AGENCY
SEPTEMBER - OCTOBER 1976.

11 3 Dec 76

14 USAEHA-42-Ø3Ø6-77

12 8p.

10 Terry L. Lyon

SERVING THE ARMY IN ITS PREVENTIVE MEDICINE PROGRAM

SENTINEL of HEALTH

US ARMY
ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MD 21010

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 42-0306-77	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) NONIONIZING RADIATION PROTECTION SPECIAL STUDY NO. 42-0306-77, EVALUATION OF THE LASER INSTRUMENTATION BEACON DEVELOPED FOR OPERATIONAL TEST AND EVALUATION AGENCY, SEPTEMBER - OCTOBER 1976		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER 42-0306-77
7. AUTHOR(s) Terry L. Lyon		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Environmental Hygiene Agency Aberdeen Proving Ground, MD 21010		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Commander US Army Health Services Command Fort Sam Houston, TX 78234		12. REPORT DATE 13. NUMBER OF PAGES 6
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Helium Neon Laser

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A laser radiation protection special study of the laser instrumentation beacons constructed for the Operational Test and Evaluation Agency by Harry Diamond Laboratories was conducted by this Agency on 16 September 1976.

Radiometric measurements indicated that these systems are Class II He-Ne laser products and, therefore, do not pose a momentary viewing hazard.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010

HSE-RL/WP

3 DEC 1976

NONIONIZING RADIATION PROTECTION SPECIAL STUDY NO. 42-0306-77
EVALUATION OF THE LASER INSTRUMENTATION BEACON
DEVELOPED FOR OPERATIONAL TEST AND EVALUATION AGENCY
SEPTEMBER - OCTOBER 1976

ABSTRACT

A laser radiation protection special study of the laser instrumentation beacons constructed for the Operational Test and Evaluation Agency by Harry Diamond Laboratories was conducted by this Agency on 16 September 1976.

Radiometric measurements indicated that these systems are Class II He-Ne laser products and, therefore, do not pose a momentary viewing hazard. It is recommended that unprotected personnel not be permitted to stare into the beam within 81 m of the laser or 1 km when viewing thru optical instruments, that the attenuating filters be used whenever possible to reduce the laser output and that the appropriate warning label be conspicuously attached to the device housing.

DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010

HSE-RL/WP

NONIONIZING RADIATION PROTECTION SPECIAL STUDY NO. 42-0306-77
EVALUATION OF THE LASER INSTRUMENTATION BEACON
DEVELOPED FOR OPERATIONAL TEST AND EVALUATION AGENCY
SEPTEMBER - OCTOBER 1976

1. AUTHORITY.

a. AR 40-5, Health and Environment, 25 September 1974.

b. Letter, DRXDO-ASD, Harry Diamond Laboratories, 11 August 1976, subject: Safety Evaluation of Helium-Neon Laser Signalling and Beacon Devices, and indorsement thereto.

2. REFERENCES.

a. AR 10-5, Department of the Army, 1 April 1975.

b. AR 40-46, Control of Health Hazards from Lasers and Other High Intensity Optical Sources, 6 February 1974.

c. TB MED 279, Control of Hazards to Health from Laser Radiation, 30 May 1975.

d. Letter, HSE-RL, this Agency, 16 September 1976, subject: Preliminary Hazard Analysis of Laser Instrumentation Beacon Developed for Operational Test and Evaluation Agency (OTEA).

3. PURPOSE. To evaluate potential health hazards associated with the use of the laser instrumentation beacon developed for OTEA and to make recommendations designed to limit exposure of personnel to potentially hazardous radiation from this device.

4. GENERAL.

a. Background. The Electro-Optics Systems Branch of the Harry Diamond Laboratories constructed several laser instrumentation beacons for the OTEA. The systems each consisted of a Metrologic Model 620 He-Ne laser. The laser beam was mechanically chopped to produce a unique "dot-dash" type of code. The beacons were developed to test various night vision devices. They will be mounted and boresighted with the night vision devices under test. Downrange observers (0.5 to 3.0 km) will determine when they are being tracked by a night vision device, and from the code they will be able to discern which device is doing the tracking.

b. Inventory. Eleven units plus two spare units were constructed by Harry Diamond Laboratories at the time of this study.

c. Instrumentation.

(1) EG&G Model 580 Radiometer System with Model 22A Detector Head.

(2) United Detector Technology Model 40X Optometer.

(3) Scientech Model 362 Disk Colorimeter.

(4) Tektronix Model 7633 Storage Oscilloscope.

d. Radiometric Terms and Units. The Appendix provides a table of the radiometric terms and units utilized in this report.

5. FINDINGS.

a. Laser Parameters. Two completed laser instrumentation beacons and six additional Metrologic Model 620 He-Ne lasers were measured on 16 September 1976 at the US Army Environmental Hygiene Agency. The two completed units (SN 633-167 and SN 632-44) were mechanically chopped at a slow rate and provided attenuation of the exit laser beam by two filters. The filter select knob was marked 100 percent, 10 percent, and 5 percent transmission. The output power of the six additional lasers (SN 634-128, SN 633-19, SN 634-135, SN 632-152, SN 633-208, and SN 631-43) was also measured. The following output parameters were obtained:

(1) Wavelength: 632.8 nm

(2) Duty Cycle: The exit beam was transmitted through the mechanical chopper 32 percent of the time. The maximum continuous on-time was 0.5 s ("dash"). The "dot" on-time was 0.09 s. The off-time between "dots" and "dashes" was 0.5 s except at the end of the cycle when it was 1 s.

(3) Modes of Operation: Two codes were evaluated: dash-dash-dot-dot and dash-dot-dash-dot. Other codes would change the duty cycle.

(4) Radiant Power: The continuous output power was between 0.51 mW and 0.97 mW for all of the eight lasers.

(5) Laser Classifications: Class II, low-power lasers.

(6) Emergent Beam Diameter: Approximately 0.12 cm.

(7) Effective Beam Divergence: 4.4 mrad at 1/e-peak-irradiance-points measured (12.5 mrad at 90 percent power specified).

(8) Polarization: Random.

(9) Filter Attenuation: 14 percent measured in the 10-percent position and 3.2 percent measured in the 5-percent position.

b. System Safety. A mechanical beam shutter was present on the completed units. A Class II warning label was present on the lasers as supplied by Metrologic. This label could be partially or completely covered by the Harry Diamond Laboratories modification, and hence, an additional label would be required to be attached to the device housing.

6. DISCUSSION.

a. Protection Standards. The potential hazard from the laser instrumentation beacons is limited to the unprotected eyes of individuals staring into the beam for periods greater than 0.25-second at close range. The protection standard for momentary viewing of a continuous visible laser is 1 mW through a 7-mm pupillary aperture within the blink response of the eye. Since none of the lasers exceeded 1 mW, they do not pose a momentary viewing hazard. Long-term purposeful staring into the beam (4 to 8 hours) reduces the permissible level to 1 $\mu W/cm^2$ averaged over a 7-mm aperture. Beyond 81 m from the laser, the irradiance was below 1 $\mu W/cm^2$ for intrabeam viewing without an optical instrument. Viewing the beam through 13-power optics would extend this caution range to about 1 km.

b. Other Standards. Since these devices may be used in OTEA tests in the Federal Republic of Germany, the applicable safety standards outside of US Army installations are different. The German standards (VBG 93) limit direct-beam exposure of the human eye to 5 $\mu W/cm^2$ for exposure durations exceeding 0.1 second. This beam irradiance occurs at a distance of 36 m from the beacon. Presumably no tests would occur within 36 m of the edge of controlled military areas.

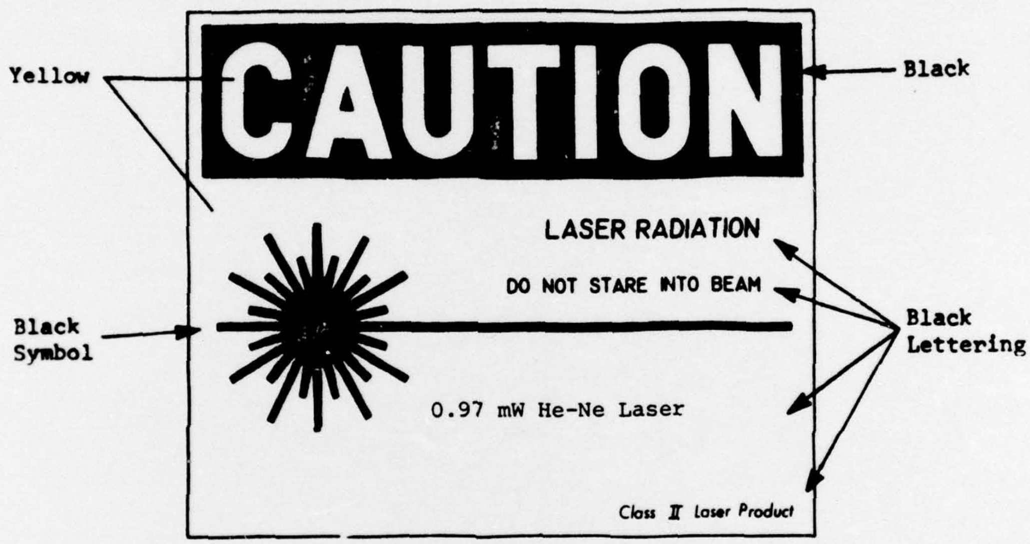
7. CONCLUSION. The laser instrumentation beacons emit optical radiation exceeding current protection standards. However, these devices may be operated safely provided that the operators are informed of the potential hazards and take appropriate precautions.

8. RECOMMENDATIONS.

a. Do not permit unprotected personnel to intentionally (continuously) stare into the beam within 81 m of the laser (or 1 km through optical instruments). Momentary viewing is not considered hazardous (paragraph 1-4a, AR 40-46).

b. Whenever possible, use the system attenuating filters to reduce the laser output (paragraph 1-4d, AR 40-46).

c. Install a warning label on the device housing such as [paragraph 1-5d(1), AR 40-46]:



Terry L. Lyon
TERRY L. LYON
Physicist
Laser Microwave Division

APPROVED:

Robert T. Wangemann
ROBERT T. WANGEMANN, Ph.D.
LTC, MSC
Chief, Laser Microwave Division

for Robert T. Wangemann LTC MSC
WILLIAM G. PEARSON
COL, MSC
Director, Radiation and
Environmental Sciences

APPENDIX

USEFUL CIE RADIOMETRIC AND PHOTOMETRIC TERMS AND UNITS[1,2]

RADIOMETRIC				PHOTOMETRIC			
Term	Symbol	Defining Equation	SI Unit and Abbreviation	Term	Symbol	Defining Equation	SI Units and Abbreviation
Radiant Energy	Q_e		Joule (J)	Quantity of Light	Q_v	$Q_v = \int \Phi_v dt$	lumen-second (lm·s) (talbot)
Radiant Energy Density	W_e	$W_e = \frac{dQ_e}{dV}$	Joule per cubic meter ($J\cdot m^{-3}$)	Luminous Energy Density	W_v	$W_v = \frac{dQ_v}{dV}$	talbot per square meter ($lm\cdot s\cdot m^{-3}$)
Radiant Power (Radiant Flux)	Φ_e, P	$\Phi_e = \frac{dQ_e}{dt}$	Watt (W)	Luminous Flux	Φ_v	$\Phi_v = 680 \int \frac{d\Phi_e}{d\lambda} V(\lambda)\, d\lambda$	lumen (lm)
Radiant Exitance	M_e	$M_e = \frac{d\Phi_e}{dA} = \int L_e \cdot \cos\theta \cdot d\Omega$	Watt per square meter ($W\cdot m^{-2}$)	Luminous Exitance	M_v	$M_v = \frac{d\Phi_v}{dA} = \int L_v \cdot \cos\theta \cdot d\Omega$	lumen per square meter $lm\cdot m^{-2}$
Irradiance or Radiant Flux Density (Dose Rate in Photobiology)	E_e	$E_e = \frac{d\Phi_e}{dA}$	Watt per square meter ($W\cdot m^{-2}$)	Illuminance (luminous flux density)	E_v	$E_v = \frac{d\Phi_v}{dA}$	lumen per square meter ($lm\cdot m^{-2}$) lux (lx)
Radiant Intensity	I_e	$I_e = \frac{d\Phi_e}{d\Omega}$	Watt per steradian ($W\cdot sr^{-1}$)	Luminous Intensity (candlepower)	I_v	$I_v = \frac{d\Phi_v}{d\Omega}$	lumen per steradian (lm·sr) or candela (cd)
Radiance	L_e	$L_e = \frac{d^2\Phi_e}{d\Omega \cdot dA \cdot \cos\theta}$ [5]	Watt per steradian and per square meter ($W\cdot sr^{-1}\cdot m^{-2}$)	Luminance	L_v	$L_v = \frac{d^2\Phi_e}{d\Omega \cdot dA \cdot \cos\theta}$ [5]	candela per square meter ($cd\cdot m^{-1}$)
Radiant Exposure (Dose, in Photobiology)	H_e	$H_e = \frac{dQ_e}{dA}$	Joule per square meter ($J\cdot m^{-2}$)	Light Exposure	H_v	$H_v = \frac{dQ_v}{dA} = \int E_v dt$	lux-second (lx·s)
				Luminous Efficacy (of radiation)	K	$K = \frac{\Phi_v}{\Phi_e}$	lumen per watt ($lm\cdot W^{-1}$)
				Luminous Efficiency (of a broad band radiation)	$V(*)$	$V(*) = \frac{K}{K_m} = \frac{K}{680}$	unitless
Radiant Efficiency [3] (of a source)	η_e	$\eta_e = \frac{P}{P_i}$	unitless	Luminous Efficacy[3] (of a source)	η_v	$\eta_v = \frac{\Phi_v}{P_i}$	lumen per watt ($lm\cdot W^{-1}$)
Optical Density [4]	D_e	$D_e = -\log_{10} \tau_e$	unitless	Optical Density[4]	D_v	$D_v = -\log_{10} \tau_v$	unitless
				Retinal Illuminance in Trolands	E_t	$E_t = \frac{L_v}{S_p}$	troland (td) = luminance in $cd\cdot m^{-2}$ times pupil area in mm^2

1. The units may be altered to refer to narrow spectral bands in which case the term is preceded by the word *spectral*, and the unit is then per wavelength interval and the symbol has a subscript λ. For example, spectral irradiance H_λ has units of $W\cdot m^{-2}\cdot m^{-1}$ or more often, $W\cdot cm^{-2}\cdot nm^{-1}$.
2. While the meter is the preferred unit of length, the centimeter is still the most commonly used unit of length for many of the above terms and the nm or μm are most commonly used to express wavelength.
3. P_i is electrical input power in watts.
4. τ is the transmission
5. At the source $L = \frac{dI}{dA \cdot \cos\theta}$ and at a receptor $L = \frac{dE}{d\Omega}$